FINAL REPORT

RESEARCH PROJECT

State: Montana

Project No.: SE-1-12 Title: Statewide Endangered Species Research

Job No.: 1 Title: Northern Rocky Mtn. Wolf Investigations

Period Covered: July 1, 1986 through June 30, 1987

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CONTENTS

INTRODUCTION

The Wolf Ecology Project (WEP) at the University of Montana has been monitoring wolf recovery in the northern Rockies since 1973. In 1983 a proposal was submitted to the Montana Department of Fish, Wildlife and Parks. The Department obtained Endangered Species Act (Section 6) funding from the U.S. Fish and Wildlife Service, and contracted with the WEP to conduct wolf monitoring in and around Glacier National Park (GNP).

The objectives of this study are:

to determine the distribution and occurrence of the Rocky Mountain wolf in northwestern Montana;

to determine the movements, habitat use and food habits of instrumented and observed wolves; and

to develop recommendations for management action necessary for wolf recovery.

STUDY AREA

This study is being carried out in and around GNP where wolves have recently returned by natural recovery (Fig. 1). The intensive study involving radio-collared wolves is being conducted largely in the North Fork of the Flathead River drainage, which includes the west side of GNP and the adjacent Flathead National Forest (FNF), as well as the headwaters of the river in British Columbia (BC). There are few human residents in the drainage in BC, in contrast to Montana (MT) where numerous permanent and seasonal residents occupy private inholdings on the FNF.

The North Fork valley is level to gently rolling, varying from 2 to 6 miles in width, and surrounded by steeper foothills and rugged mountains. The wolves have mainly used the valley bottom, but travel considerable distances up and down the valley. The valley elevation is approximately 4000 feet and it is mostly forested with lodgepole pine (Pinus contorta). Grassy open meadows, marshes, and riparian habitats make up an important portion of the wolf locations.

The 4 most significant prey species are white-tailed deer, mule deer, elk, and moose (see Appendix I for scientific names). These 4 species differ considerably in their distribution in the study area. Because of increasing snow depths as you move north up the valley, white-tailed deer are primarily found south of Polebridge in winter, and on the south-facing slope at Kintla Lake. In summer they are found in the valley bottoms throughout the drainage. Mule deer also move down the valley in winter, using the valley around Polebridge and open ridges and steep rocky slopes elsewhere. In summer they may be found throughout the drainage but usually in the higher, more rugged portions of the area. Elk are found as far north as about 20 km north of the U.S. border in BC in the winter and may be found anywhere in the drainage in

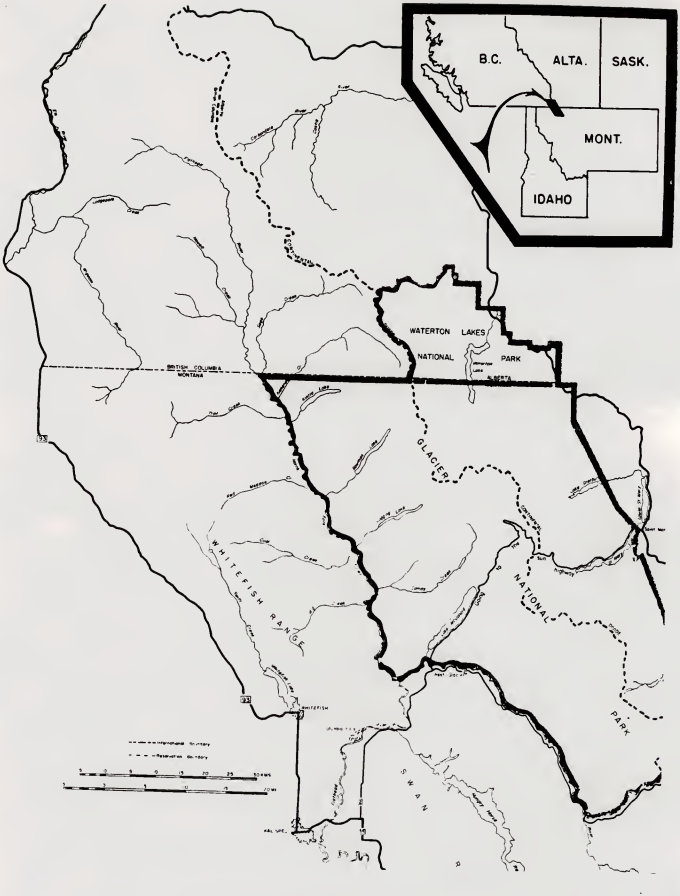


Figure 1. Study area.

summer. In winter they use meadows and south-facing slopes in the valley itself. Moose are scattered throughout the area in both summer and winter but move to lower elevations in winter. Relatively little is known about ungulate populations in the North Fork in MT, but Jenkins (1985) established winter track transects and related ungulates to habitat and snow depths.

BACKGROUND

During the late 1800's and early 1900's, wolves were extirpated throughout most of their historic range through intensive wolf removal efforts by humans (Mech, 1970). It appears that they were totally eliminated from Montana, though occasional wolves have been killed in recent years (Day, 1981; Ream & Mattson, 1982), apparently dispersers from Canada. Lack of wolf killings and sign indicated that wolf numbers were severely reduced in northwestern Montana (Singer, 1979). This status remained unchanged until the early 1980's when wolves began to naturally repopulate the North Fork of the Flathead drainage of British Columbia (BC) and adjoining Glacier National Park (GNP) and the Flathead National Forest (FNF) in Montana (Ream & Mattson, 1982).

Home Range of Wolf W114

Day (1981) and Ream and Mattson (1982) investigated wolf observations and reports in Montana prior to 1980, and Singer (1979) investigated wolf reports in and around GNP. Based on 1972 to 1979 wolf reports, intensive investigations were initiated in the northern Rocky Mountains in autumn 1978 and resulted in capture of W114, a 36 kg gray female wolf (Ream and Mattson, 1982). She was captured and radio-collared on 8 April 1979, 10 km north of GNP in British Columbia (BC), and her movements were monitored for 16 months until her radio apparently failed in July 1980 (Ream et al., 1985). During the subsequent 14 months all wolf tracks observed in the North Fork drainage were of a single wolf and evidence indicated that W114 was the only wolf inhabiting the study area (Ream et al., 1985). There was no evidence of denning activity by W114, or any other wolf, in 1979, 1980 or 1981.

The home range for W114, based on 125 radio locations, is shown in Fig. 2 (from Ream et al., 1985). Her home range during winter months occupied an area just north of GNP and extending approximately 20 km north into BC. During summer months she occupied that area but also moved to the headwaters of the North Fork for periods of 1-2 weeks, returning to the southern portion of her range with little time spent in between. Only 1 location was south of the border, within GNP.

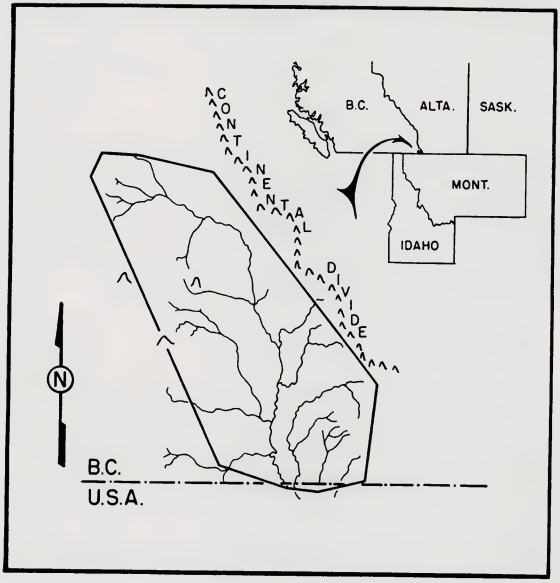


Figure 2. Home range of W114 (taken from Ream et al. 1985).

Formation of First Pack - 1981-84

In autumn 1981, a large black wolf was observed (Ream et al., 1985) and tracks of a large, 3-toed wolf were observed and cast by U. Mattson (pers. commun.) just north of GNP, within the home range of W114. In late February 1982, tracks of a male and a female wolf traveling together were observed in the northwestern corner of GNP (D. Boyd & J. DeSanto, pers. commun.). Sex was inferred from urination patterns observed on the snow (raised leg urinations for males and squat urinations for females). The female had blood in her urine, indicating a proestrus condition (Seal et al., 1979). The male was missing one toe on the left front foot. Since W114's radio was no longer functioning, we had no way of determining whether she was the female or if another wolf had moved in with the 3-toed male.

On 19 June 1982 a black adult, male, 3-toed wolf was accidentally captured in a grizzly bear leg-hold snare 12 km north of GNP (Ream et al.,1985). He (W113) was radio-collared and released, but was found dead from unknown causes the following day, 0.5 km from the capture site. On 25 June 1982 a black wolf pup was seen 5 km southeast of the dead male's capture site (B. McLellan, pers.commun.). During the following month a litter of 7 pups, 4 gray and 3 black was observed several times. Based on discovery of this litter and location of the rendezvous site, W113 was probably the father of the litter. The female was apparently successful in raising most of the litter after the death of W113, because the following winter, tracks of 6-7 wolves were observed and in the summer of 1983 pack howling was heard on several occasions (B. McLellan, pers. commun.).

Beginning in November 1983 and continuing through the following winter, a gray and dark-saddled male wolf was observed in the border area and as far as 35 km south of the BC border. He appeared to be a subadult male (D. Boyd, pers. commun.), likely from the 1982 litter of pups. During the first 3 months of 1984, a pack of 2-3 wolves was observed in the vicinity of the border and the following summer a litter of pups was reported seen by a geologist 7 km west of the 1982 rendezvous site (B. McLellan, pers.commun.). Our project was not funded from 1 July 1981 until late July 1984, though D. Boyd lived in the area and bear researcher B. McLellan also made valuable wolf observations. Observations during that time are credited to those 2 individuals, GNP ranger J. DeSanto, volunteer Dean Marsh, and residents of the North Fork.

METHODS

Because of the elusive and wide-ranging habits of wolves, capturing, radio-collaring, and releasing wolves appeared to be the best way to address the objectives of this study (Mech 1982). Radio telemetry provides the only means to objectively monitor wolf movements year-round and collect scats and discover kills regularly, especially in a coniferous forest ecosystem. By radio-tracking wolves, it is also possible to determine pack struture and habitat use, follow dispersal, elucidate predator-prey interactions, productivity and survivorship patterns, and locate den and rendezvous sites.

Another major advantage of radio-telemetry is that it provides the means for researchers to avoid the study animals, hopefully minimizing any disturbance or bias created by research activities.

Wolves were trapped primarily along roadsides with modified Newhouse No. 4 (Woodstream Corp.) and Braun (Wayne's Oddjobs, Ltd.) leg-hold traps. Modifications to the Newhouse traps included the replacement of the smooth jaws with 1.8 cm offset toothed jaws (making the trap a No. 14 OS) and the replacement of the original dog/pan mechanism with a pan spring mechanism (M-Y Enterprises) to reduce captures of smaller, non-targeted species.

Traps were attached by swivel to 1.8 m of twisted link chain and a 2-pronged steel drag hook. The traps were buried freely in the ground, allowing a trapped animal to leave the immediate area of the capture site with the drag hook eventually hanging up in brush or small trees.

Wolves were initially immobilized and sedated with ketamine HCl (11 mg/kg wolf) and promazine HCl (2.2 mg/kg wolf) deliverd with a jab stick. Boosters of 100 mg ketamine HCl were injected if a wolf began to struggle before handling was completed.

Captured wolves were examined, ear-tagged, weighed, measured, and radio-collared (Telonics, Inc., Mod500) before release. Each trapped wolf was examined carefully for trap-related or other injuries. A detailed description of all injuries (if any) to each animal was recorded. The extent of any injuries to each wolf was then categorized following Van Ballenberghe (1984). After processing each wolf, personnel remained nearby to observe the wolf until it could leave the site on its own. Provisions were made, with the cooperation of Glacier National Park and Ashley Creek Animal Clinic (Kalispell, MT), to handle and care for any wolf which suffered a severe injury due to the research trapping effort. Fortunately, this was not necessary during this study.

Radio-collared wolves were usually located daily from the ground. Locations were determined by triangulation of at least 3 azimuths, but usually 4 or more, and described as Universal Transverse Mercator (UTM) coordinates to the nearest 0.1 km. The UTM grid locations, date, time, number and color of any wolves seen, land ownership, ground or aerial location, and commentary were recorded on data sheets and entered in computer files.

If more than 2 days passed when a radio signal from a Magic Pack wolf could not be received from the ground, a Piper Super-Cruiser or a Cessna 182 aircraft was used to aerially radio-track the wolves, weather permitting. Because of the remoteness of most of W8401's locations, he was aerially radio-tracked on a 7-10 day schedule.

During the denning season, and occasionally at other times when wolves were moving rapidly, more than 1 location was obtained each day. This provided information on densite attendance and movement patterns. However, to eliminate bias in analyzing home ranges and movements, only 1 randomly selected location per day was used for this report. Wolf home ranges were described using minimum convex polygons calculated with the McPAAL v1.2 home

range analysis program (Stuwe and Blohowiak, n.d.) and the home range programs of Samuel et al. (1985) modified for the University of Montana by M. Haroldson and R. Matchett.

Wolf numbers were estimated from aerial counts whenever wolves could be observed from the air. Visual observations from the air were only considered adequate for estimating numbers when a pack or suspected loner was in an area with good visibility. If wolves were in thick coniferous vegetation little time was spent circling in the aircraft. This minimized any possible disturbance to the wolves and to any park visitors (when over GNP) when a good count could not be achieved anyway.

When snow cover was present, wolf radio locations were used to determine routes researchers could take to intercept wolf tracks. Wolf trails were backtracked and occasionally forward tracked depending upon the proximity of the wolves. We always strived to avoid any areas where wolves were present. Combining radio-location data with knowledge of recent snowfall, scats and carcasses found along the wolf trail could be aged. The minimum number of wolves being followed was estimated and compared with aerial counts to estimate pack sizes at different times.

Scats were collected for content identification only if they were accompanied by wolf tracks or at a known wolf homesite as determined by radio-tracking. Collection date, estimated age, location, estimated minimum number of wolves present, pack affiliation or lone wolf identification, and maximum diameters of the scats were recorded. Scats were not collected around identified carcasses where wolves were known to have fed. Scats were autoclaved and washed to remove soluble materials. Five guard hairs per scat were randomly selected and identified using identification keys (Moore et al., 1974). Hairs were identified to species when possible, except for mule deer and white-tailed deer hair which were identified just to the genus Odocoileus. All identification of hairs were done by Dan Pond, Stevensville, MT. When more than one species was found in a scat, the proportion of each item was estimated. Relative frequency of occurrence was calculated for each item identified in the wolf scats for 3 seasons; spring-summer, autumn, and winter. Relative biomass of prey items was estimated using the regression equation of Floyd et al. (1978). Wolf hairs were excluded from the analysis because they were probably ingested while grooming.

Carcasses found along wolf travel routes were categorized as known, probable, or scavenged. Carcasses were identified to species and sex when possible. Age in years was assigned by tooth replacement for first year and yearling animals (Quimby and Gaab, 1952; Severinghaus, 1949) and cementum annuli (Lockard, 1972) for Incisor 1 when a mandible could be found. Aging by the cementum annuli method was done for ungulates by Matson's Laboratory, Milltown, MT.

Percentage of the carcass consumed was estimated and the remains described in a narrative. Bone marrow fat from the middle third of a femur was subjectively rated by color and texture (Cheatum, 1949).

A hunter check station at the junction of the North Fork Road and Camas Road was operated each weekend of the 1985 and 1986 hunting seasons. The number of successful and unsuccessful hunters was recorded, as was sex and species of each animal that was checked through the station. Most of these carcasses were aged as described above. Some carcasses came through the check station without heads and these could not be aged.

RESULTS AND DISCUSSION

TRAPPING

Trapping efforts during the study, August 1984 to July 1987, resulted in 15 captures of 10 different wolves (Table 1). Additionally, 1 wolf was captured in an Aldrich cable foot snare by bear researchers and fitted with a WEP radio-collar. Trap nights per wolf capture during different trapping periods ranged from 61 to 539 (Table 2). Walking the trapline daily may have left too much human scent, resulting in a decreased capture rate.

The incidence and type of foot and leg injury was recorded (Table 3) and classified according to Van Ballenberghe (1984). Including all trap types, 31% were Class 1, 44% were Class 2, 19% were Class 3, and 6% (1 wolf) was Class 4. Class 3 and 4 injuries for WEP captures involved broken or dislocated toes, with no injuries to carpals or leg bones. There was only 1 Class 4 injury and when that wolf was recaptured 8 months later, no evidence of the 2 broken toes was noted. Trap injuries in this study have not resulted in any noticeable long term effects, based on examination of the 5 recaptured wolves and on visual observations. Using the same classification (Table 3), our injury rates were more damaging than those reported by Kuehn et al. (1986), but considerably less severe than those reported by Van Ballenberghe (1984).

PHYSICAL CHARACTERISTICS

Study wolves varied a great deal in pelage color, from black to light gray. Forty-five percent of captured wolves were gray and 55% were black. The color ratios are constantly changing with recruitment and mortalities, with our most recent documentation of the entire known study population being 11 gray (44%) and 14 (56%) black, as of June 1, 1987. Cowan (1947) found a color proportion of 45% gray and 55% black for 80 wolves observed in several Rocky Mountain National Parks in British Columbia and Alberta. Fritts and Mech (1981) captured no blacks, 38 gray, and 1 white wolf in northcentral Minnesota during the 1970's. Peterson et al. (1984) found that 32% of the wolves in his Kenai peninsula, Alaska, study area were black. Goldman (1944) stated that C.l. occidentalis and C.l. columbianus are large subspecies where the black color phase is common; C.l. irremotus is a medium to large

Table 1. Biological and Capture Data for All Wolves Trapped Within the Study Area From 1984-87.

Wolf	Eartag L	Eartag R	Sex	Date Captured	Color	Age[a]	Weight (kg)	Total Length (cm)	Neck Collar Circum (cm)	(cm)	Capture Site	Fate and Comments
8401	3	5	M	08-26-84	gray	adult	48	184	-	-	BC	transmitting
8401	13	14	M	10-25-85	gray	adult	46	-	-	-	BC	new collar transmitting
8550	-	-	F	05-18-85	lt gr	adult	37[b]	-	-	-	BC	transmitting
8502	7	8	M	09-07-85	black	5 mos	30	147	41	-	BC	lost collar 09-08-85
8551	12	11	F	09-09-85	black	5 mos	22	145	36	54	BC	transmitting
8551	12	11	F	05-22-86	black	13mos	34	164	42	54	BC	dispersed died 07-11-87
8552	10	9	F	09-09-85	black	5 mos	28	152	38	51	BC	lost collar 09-10-85
8653	16	15	F	05-28-86	black	adult	44	183	45	46	BC	transmitting
8653	16	15	F	05-15-87	black	adult	41	181	-	48	GNP	new collar transmitting
8654	17	18	F	10-09-86	gray	6 mos	32	-	41	46	GNP	signal quit 05-12-87
8654	17	18	F	06-08-87	gray	14mos	42	183	39	48	BC	new collar transmitting
8703	19	-	M	05-16-87	gray	adult	46[b]	177	47	53	GNP	transmitting
8755	21	20	F	05-19-87	black	adult	36	175	43	50	GNP	transmitting
8755	21	20	F	06-24-87	black	adult	-	-	-	-	BC	transmitting
8704	22	23	M	06-12-87	black	adult	51	179	44	50	BC	transmitting
8705	24	-	M	06-19-87	gray	adult	51	193	45	50	BC	transmitting

[a] adult is yearling or greater
[b] estimated weight

subspecies where the black color phase is extremely rare. Multivariate analysis of recent wolf skulls from se BC and nw U.S. strongly suggests that the wolves found there now have migrated south from Canada and are not remnant populations of C.l. irremotus which formerly occupied this area (Friis 1985). Based on these reports and our size and color data (Table 1), the wolves now occurring in the study area are probably not C.l. irremotus, but more likely C.l. columbianus or C.l. occidentalis. Further study is needed.

Mean weights of adult and yearling wolves were 39 kg (34 - 43, n=5) for females and 49 kg (46 - 51, n=4) for males. Four pups were captured during the autumns of 1985 and 1986. Two 5-month old female pups from the same litter were captured on the same day in September 1985, weighing 22 and 28 kg. A male littermate captured 2 days earlier weighed 30 kg. A 6-month old female captured in October 1986 weighed 32 kg (Table 1).

Two of the female pups were recaptured as yearlings the following spring. They had increased their weights from 22 to 35 kg and 32 to 42 kg. Wolves reach their adult weights by the time they are one year of age (Mech, 1970). Thus, these two wolves had achieved 63 and 76 percent of their adult weights as 5 and 6-month old pups, respectively.

Table 2 Trapping Success Within the North Fork Study Area from 1984-87.

Trapping Period	Total Trap Nights	Wolves Captured		Trap Nights per Wolf	Trapline Transport.	Trap Area
08-16-84 - 08-26-84	155	1	8401	155	Truck	BC
09-07-85 - 09-21-85	a	3	8551	a	Truck	BC
			8552			
			8502			
10-15-85 - 10-25-85	139	1	8401	139	Truck	BC
05-13-86 - 06-02-86	a	2	8551	a	Truck	BC
			8653			
09-24-86 - 10-22-86	539	1	8654	539	Foot	GNP
05-07-87 - 05-19-87	183	3	8653	61	Truck	GNP
			8703			
			8755			
06-04-87 - 07-02-87	769	4	8654	192	Truck	BC
			8704		ATC	
			8705			
			8755			

a - trap nights were not recorded, but trap success was approximately the same as 1984.

Table 3. Wolf foot and leg damage caused by trapping capture.

Wolf #	Injury Class [a] 1	2	3	4	Trap Type [b]	Comments
8401	X				14 OS	
8401	X				14 OS	
8550	X				Aldr	
8551		X			14 OS	
8551		X			14 OS	
8502		X			14 OS	
8552	X				14 OS	
8653				X	14 OS	2 middle toes broken.
8653		X			14 OS	Caught by same foot. No toe damage noted.
8654	X				14 OS	
8654		X			Braun	
8703			X		14 OS	1 middle toe broken.
8755		X			14 OS	
8755		X			14 OS	
8704			X		14 OS	1 middle toe dislocated.
8705			X		14 OS	1 middle toe broken.
Total %	31%	44%	19%	6%		
Kuehn et al. 1986	3%	97%	0	0	14 OS	N=40
Van Ballenberghe, 1984	20%	36%	33%	11%	Various	N=109

[a] Class 1 = no visible injuries or slight swelling;
Class 2 = cut(s) <2.5cm long is aggregate;
Class 3 = cut(s) >2.5cm long and/or 1 injured (fractured or dislocated) phalanx or metacarpal;
Class 4 = >= 2 injured phalanges or metacarpals, and/or injured carpal(s), radius, or ulna

[b] 14 OS - #14 Newhouse Offset Trap
Braun - Braun wolf trap with padded jaws
Aldr - Aldrich cable foot snare

Van Ballenberghe and Mech (1975) constructed a standard weight table from which they compared the age specific weights and survivorship of wolf pups in Minnesota. They concluded that "pups less than approximately 65 percent of standard weight have a low chance of survival, those at least 80 percent of standard have high survivability, and those between 65 and 85 percent of standard depend critically on improved nutrition for survival to yearling status." Sixty-nine wolf pups ranged from 31 - 144 percent of standard weights in the Minnesota study. Comparing the weights of the 4 pups captured in this study to the same standard weight table gives values of 147, 187, and 173 percent of standard for females and 182 percent for the male. While wolf pups in the Rocky Mountains can be expected to be heavier than their Minnesota counterparts due to subspecific variation, these values indicate that the wolf pups in this study were on a high nutrional plane.

Some difficulties were encountered when fitting pups with collars. Neck and collar circumferences were measured (Table 1) to aid in the proper fitting of pup collars to allow for growth. Collars were fitted large enough to allow room for growth by fastening them at adult circumference and temporarily reducing the circumference with foam padding and tape. The average female grew from 38 cm as a pup to 44 cm as an adult. The average male, for the same age period, grew from 41 cm to 45 cm. Two of the first three pups captured slipped their collars soon after being instrumented. Their collars had been fastened larger than necessary. Two other pups retained their collars and, when recaptured as yearlings, showed no evidence of their collars being too tight. The neck circumferences reported here should reduce future problems in fitting pups with radio collars in this region. Caution should be taken in extrapolating this information for radio-collaring wolves in other areas.

NATALITY AND MORTALITY

The first observations of pups in a season generally occurred in early- to mid-June when pups began spending more time in the open. They were observed while aerially radio-tracking instrumented adults. It could not be determined if, or how much, pup mortality occurred before the first pup counts. Therefore, pup counts represent a minimum reproductive effort. Project personnel did not examine dens until the entire pack had abandoned them, generally mid- to late-August, to avoid disturbing the wolves.

It was easy to distinguish between pups and adults through September because of obvious size differences. By October however, pups were nearing adult size and definite size distinction was difficult to discern. The great variability of pelage color, in addition to the aid of telemetry, allowed for visual identification of individuals. Six litters of wolf pups were documented in the study area (Table 4). Survivorship of the 1982 litter was unknown. However, based on recruitment for the following two years (prior to sexual maturity of the 1982 pups) and pelage color of wolves seen in the area in 1983-85, it is probable that survivorship was 100%. All of the 1985 pups and 60% of the 1986 pups were with their pack at 9 months of age (Table 4). Two of the five 1986 pups disappeared between August and November.

Table 4. Production and survivorship of wolf pups in the North Fork study area from 1982-87.

Year	adults in May	pups in early June	pups surviving to > 9 months	Location	Alpha Female
1982	2	7	unknown	BC	?
1985	6	7	7	BC	8550
1986	8	5	3	GNP	8550
1987					
SCP[a]	5	5	NA	BC	8550
CP	3	6	NA	GNP	8653
WP	2	4	NA	BC	?

[a] SCP - Sage Creek Pack
CP - Camas Pack
WP - Wigwam Pack

Litter size averaged 5.7 pups for the 6 litters documented. This reproductive rate is higher than that of most other reported studies (Table 5). and may result from 2 factors: first, this low density wolf population is expanding into unoccupied wolf habitat with abundant ungulate populations and appears very healthy; and second, the high average litter size may only be an artifact of our small sample size (number of litters observed).

Three wolf mortalities were documented between April 1979 and August 1987, all human caused. A black, male, 3-toed wolf, believed to be the alpha male of the first reproducing pair in 1982, died that summer (see Background). A gray adult wolf was illegally shot during the big game hunting season in BC on 20 October 1985. Female wolf W8551, captured and radio-collared as a 5 month-old pup, dispersed from the Magic Pack in December 1986. The BC Wildlife Branch notified us that she had been shot on 11 July 1987 near the Peace River in Alberta. Four black wolves were missing from the Magic Pack in mid-February 1986. It is not known if they died or dispersed.

Table 5. Mean number of wolf pups produced per litter reported in early summer from selected studies.

Author	Area	Ave # pups/litter	(N)
Present Study	se BC & nw MT	5.7	(6)
Carbyn (1974)	Jasper Nat Park, Alb.	4.4	(5)
Ballard et al.(1987)	s-central AK	5.5 - 5.6	(28)
Fritts & Mech (1981)	n-central MN	4.7	(18)
Cowan (1947)	se BC & sw Alb.	5.0	(4)
Kellsal (1968)	NW Territories	4.0	(5)
Stenlund (1955)	n MN	6.4	(8)
Peterson et al.(1984)	Kenai, AK	4.1	(14)

DESCRIPTION AND HISTORY OF RADIO-COLLARED SOCIAL UNITS

All radio-collared wolves were found associated with 1 or more wolves for at least part of the study period. W8401, the first wolf captured, was a lone wolf most of the time, but in autumn 1986 and the following winter he was with another wolf. In June 1987 they were found with pups and became the Wigwam Pack. The major pack through most of the study was the Magic Pack, but in winter and spring of 1987 this pack split into the Camas Pack and the Sage Creek Pack, both with 1987 dens.

Figure 3 shows the history of all known wolves in the North Fork since the first wolf was captured and radio-collared in 1979. During the winter preceding capture of W114, in April 1979, a black wolf was observed by B. McLellan (pers. commun.). Neither this black wolf nor any other appeared to be present during the 14 months W114 was radiotracked, nor for a year afterwards. W114 did not den in 1979 or 1980. Figure 3 thus presents the history of wolf recovery in the GNP area, the first recovery to be documented in the northern Rocky Mountains of the U.S. The study covered in this report, began with the capture of W8401.

W8401 and Wigwam Pack (WP)

On 28 August 1984 we captured and radio-collared a 48 kg gray and dark-saddled young male wolf (W8401) 4 km north of GNP, probably the same male observed near the border in November 1983. W8401 was the only wolf captured that year. Throughout the winter of 1984-85 sign of the Magic Pack, containing 6 wolves, was observed on both sides of the border in the area where W8401 was captured. W8401 was not observed associating with this pack, although his home range overlapped that of the Magic Pack. All locations for W8401 during the study period are shown in Figure 4.

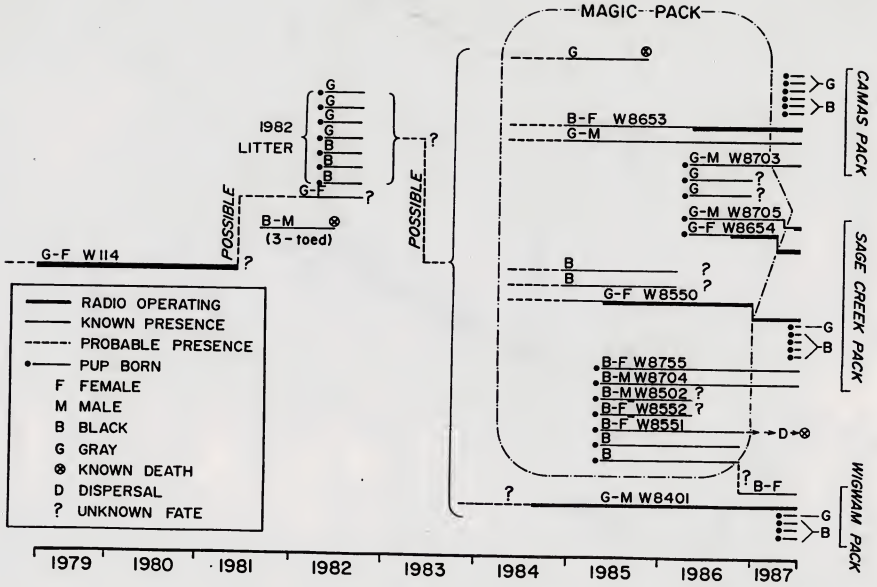


Figure 3. History of Wolves in Study Area.

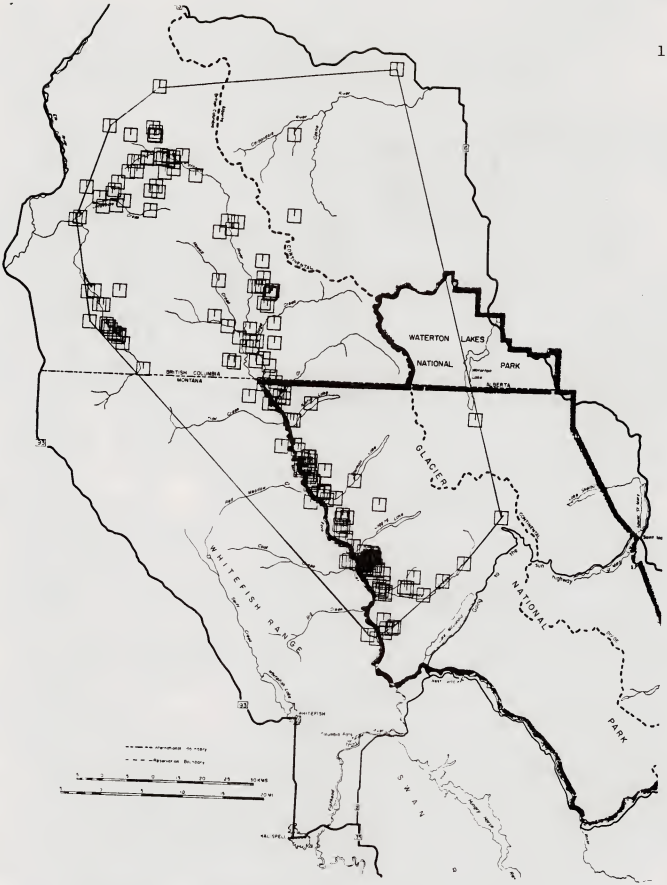


Figure 4. Home range and all locations of W8401 during study period.

After capture, W8401 remained in the vicinity of the border until 17 November 1984, when he shifted his home range south approximately 50 km into GNP. He remained in GNP, mostly south of Polebridge, through autumn 1984 and winter 1985. On 20 May 1985 he had moved north almost to the border and was subsequently located on 22 May on the other side of the Whitefish Range in the Wigwam River drainage, 20 km west of the North Fork Flathead drainage. He remained there until 26 May and was temporarily lost until 1 June when he was located close to Logan Pass. Between those 2 locations he crossed the Whitefish Range, the North Fork Valley, and was nearly to the Continental Divide, a straight line distance of 85 km. Two days later he was 1 km south of the south tip of Waterton Lake and on 16 June he was back in the North Fork valley in GNP. From there he moved to the headwaters of the North Fork where he spent the remainder of the summer, except for 2 trips across the Continental Divide into Alberta.

In the autumn of 1985 and winter of 1986 he again moved south into GNP and had a home range similar to the previous winter. However, from 11 November through the winter he shared GNP with the Magic Pack, as they moved down into GNP for the winter. Although W8401 shared the winter range with the Magic Pack geographically, he appeared to separate himself from the pack temporally. When they moved into an area where he was, he usually moved elsewhere. However, during the February breeding season, he was often found very close, sometimes less than 0.5 km, to the Magic Pack, though not amongst them.

W8401 again spent the summer of 1986 at the headwaters of the North Fork, and beginning 8 November 1986 was observed with a black wolf. This pair moved down into the Wigwam River drainage where they spent the winter. They remained there through the breeding and denning season and on 18 June we found that they had a litter of at least 3 pups. The minimum pup count for this litter was increased to 4 on a subsequent radio-tracking flight.

It appears that the pack he and his mate have initiated will make the Wigwam drainage their home and we now call them the Wigwam Pack. We believe W8401 was one of the litter of pups born in 1982, which formed the Magic Pack, yet he was not part of that pack when captured on 28 August 1984 and did not obtain a mate until autumn 1986.

W8550 and the Magic Pack

The Magic Pack of 6 wolves was tracked in the snow many times during winter 1984-85 but we had no collar on any member of the pack. On 18 May 1985, B. McLellan captured lactating female wolf W8550 in his grizzly bear leg-hold snare and placed a radio collar on her. We subsequently found 7 black pups at her densite 10 km north of GNP, which brought the Magic Pack to 13 wolves. The area near the den served as the rendezvous site throughout the summer until early September when the pups started traveling with the pack. No trapping was conducted through summer 1985 but when trapping was resumed in September, 3 pups were captured: female W8551, female W8552, and male W8502. All were radio- collared, but W8502 and W8552 slipped their collars within 2 weeks.

Through October 1985, the 7 pups traveled with the 6 adults of the Magic Pack in BC, and on 20 October an adult pack member was killed. On 10 November the remaining 12 members of the Magic Pack left BC and moved south into GNP where they established a new home range that extended to 40 km south of the border (Figure 5). The 10 black and 2 gray wolves spent the entire winter moving up and down the North Fork valley in GNP. Between 7 February and 28 February 1986, 4 black wolves, all without radios, left the Magic Pack. Once during the winter the Magic pack was 6 km north of the border and from 4 April to 9 April 1986 they were north of the border, but by 17 April W8550 had settled into her new den in GNP approximately 16 km south of the BC border. The last weeks of 1986 and early months of 1987 produced some very dramatic dispersals of wolves from the Magic Pack, and ultimately, some major shifts in pack structure.

Dispersal of W8551 From Magic Pack

Female W8551 was captured as a Magic Pack pup in September 1985 and remained with the pack until December 1986. During the 1986 denning season she remained in close proximity to W8550's litter of pups and was nearly always present when W8550 was absent from the den or rendezvous site. On 12 December 1986, W8551 moved into Canada with the Magic Pack where they remained for about a week. She was located alone north of the border on 19 December and the pack was located about 15 km south of the border the next day, without W8551. She apparently left the Magic Pack rather abruptly and travelled north and was not located again. Extended aerial searches on 22 January 1987, 9 February, 23 March, 2 April, 17 May and 1 July failed to locate W8551.

On 22 July 1987, the BC Wildlife Branch notified us that W8551 had been killed near the Peace River in Alberta, about 18 km southeast of Pouce Coupe, BC, 840 km north of GNP and about 890 km north of the winter range of the Magic Pack in GNP (Figure 6). She was taken on 11 July by a landowner who saw her traveling across his land with a gray wolf. This dispersal distance equals the record dispersal reported by Fritts (1983) for a young male from Minnesota. This is probably a record dispersal movement known for a female wolf.

Dispersal of Alpha Female W8550 From Magic Pack

Female W8550 was the alpha female of the Magic Pack and mother of both the 1985 litter of pups just north of GNP and the 1986 litter in GNP. On 22 January 1987 she was observed from the air with other members of the Magic Pack near Anaconda Creek, about 16 km south of Polebridge. At 0915 on 24 January, she was radio-tracked from the ground and located, along with other radio-collared members of the pack, in the same general area. However, at 0930 on 25 January, other radio-collared members of the pack were in that same area, but W8550 was not found. Two days later she was located at the BC/Montana border near the Flathead River. On 1 February and 8 February a lone wolf howled where W8550 was located from the ground. She was observed alone by local residents several times in February and from the air on 23 March and 3 April. Apparently she had been displaced as the alpha female in the Magic Pack and left the pack 25 January.

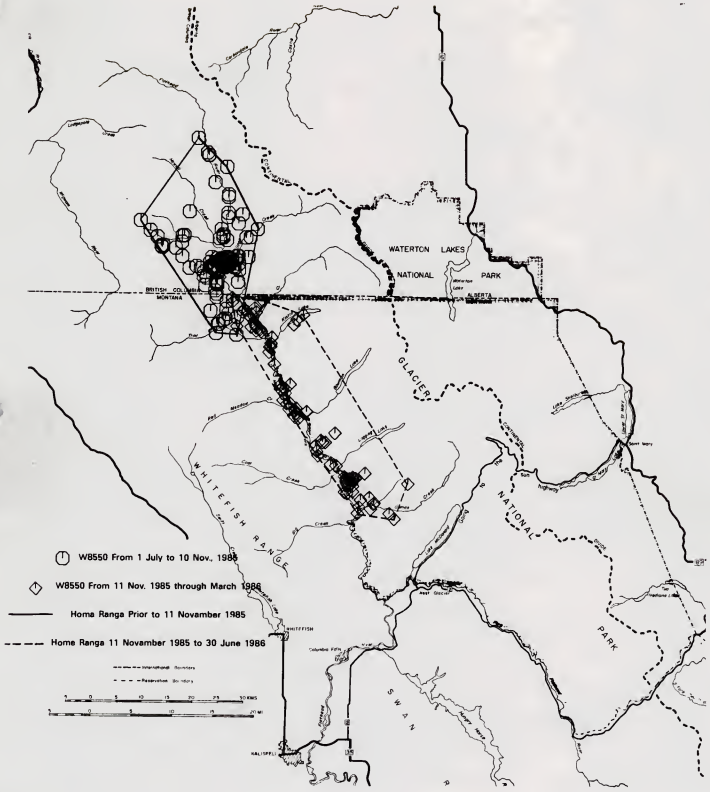


Figure 5. Shift in home range of Magic Pack in 1985.

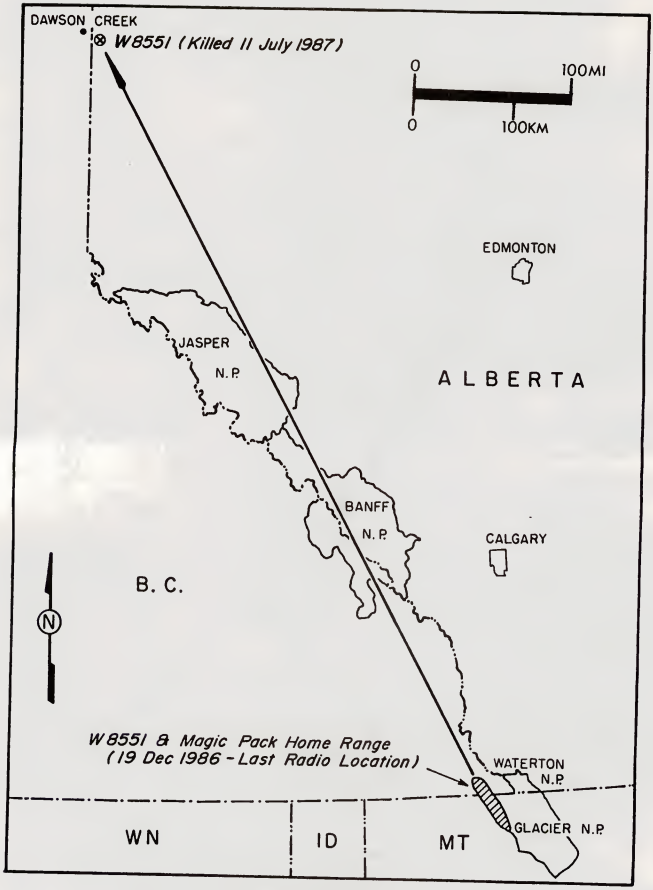


Figure 6. Dispersal of W8551 from Magic Pack.

Formation of Sage Creek Pack

After spending 3 months alone, W8550 was apparently joined by 2 other members of the Magic Pack. At 2230 on 1 May 1987 we got a strong signal from her radio at the WEP cabin at Moose City on the Canadian border. We then elicited a howling response from 3 wolves that were about 200 m west of the cabin. On 5 May 1987, W8550 and 2 black wolves were observed from the air. On 10 June 1987, 2 gray wolves were observed from a truck, one of them W8550. At this point in time we knew that W8550 had been joined by other wolves to form a pack of at least 2 gray and 2 black wolves.

At 1400 on 25 April 1987, W8654, a yearling female was with the remaining members of the Magic Pack 10 km south of Polebridge. By 0400 the next morning, she was 23 km northwest of the pack and by 1420 on 27 April she had moved 15 km further northwest, almost to the Canadian border. W8654 continued to move north until 11 May when she was located 50 km north of the border. W8550 was located in the same area that day but no visual observations were made from the air. After that we could no longer get a signal from W8654 despite some lengthy aerial searches. However, on 8 June 1987, W8654 was recaptured near W8550. Her collar was still on, but it had malfunctioned immediately after the 11 May location. On 10 June, W8654 was located very close to W8550 and apparently had joined the new pack, for she was subsequently found with the pack for the remainder of June.

On 19 May 1987, black adult female W8755 was trapped 8 km south of Polebridge in the area that the remaining members of the Magic Pack were using and only 7 km from W8653, the new alpha female of that pack. The posterior 6 mammae of W8755 were slightly swollen with milk but the nipples were undeveloped. Such "false pregnancies", where non-breeding females experience the same hormonal cycles and manifestations as breeding females (e.g., lactation), have been observed in captive wolves (Packard and Mech, 1983) and are not considered rare (L.D. Mech, pers. commun.). After being trapped, W8755 started moving north, and on 22 May was with W8550 and other members of the new Sage Creek pack, where she has remained.

Trapping was initiated in the vicinity of W8550 on 4 June and in addition to the recapture of W8654, new captures were made for black male W8704 on 12 June, and on 19 June for gray male W8705. Both immediately joined W8550 and other members of the Sage Creek Pack, which now contained 3 female and 2 male radio-collared wolves.

On 14 June 1987, an aerial observation was made of a gray adult and at least 3 pups at a den. Subsequent flights in July and August indicated that there were 5 pups new to this pack. Females W8654 and W8755, having been just recently captured and examined, were discounted as possible breeders. Unless another female was present with this pack, this indicates that W8550 was the mother of the 1987 litter in this new pack. However, through late April and early May, W8550 was traveling widely and on 17 May was 25 km north of the densite. From 22 May through June she was consistently at or close to the den. If she is the mother of the litter, it appears that she whelped a month later than she had the previous 2 years. Her apparent 1987 den is less than

1 km south of her 1985 den, while in 1986 her den was 30 km south of this in GNP. With 5 new pups the Sage Creek Pack apparently has 10 members.

Camas Pack, Remnants of the Magic Pack

After W8550 was displaced from the Magic Pack as its dominant female on 25 January, 4 other members of the pack apparently moved north and joined her over a period of 3-5 months after she left. W8551 had already left the previous December. Thus 6 of 9 wolves that were part of the Magic Pack in early December 1986 left the Pack and its previous year's winter and spring home range by the end of May, 1987.

Female W8653 was the only radio-collared wolf remaining in the Magic Pack and apparently assumed dominance during winter 1987. Beginning on 23 April 1987 she was consistently radio-located in the same restricted area. She was verified to be the mother of this pack's litter when she was recaptured on 15 May, 8 km north of her den. Her mammaries were very swollen with milk and she had obviously been nursed. Trapping was conducted no closer than 8 km from the den from 7 May to 19 May and resulted in the capture of a gray, yearling male, W8703, in addition to W8755 and W8653.

Subsequent observations, from the air and on the ground, revealed that there were 3 adults and 6 young of the year in this pack. Rather than call this pack the Magic Pack, when 6 wolves had left and formed a new pack, leaving only 3 behind, we now call the remaining 3 adults and subadults, with the 6 young of the year the Camas Pack. W8653 and W8703 are the radio-collared members of this pack.

The 2 "new" packs that originated from the 1986 Magic Pack have 9 and 10 members each counting the young of the year. How the 2 packs relate to each other will be of great interest during the next year. It is possible that the 2 packs, or at least some members of each, may join again, now that the breeding and denning seasons are over. However, it is unlikely that all 18 would function for long as one pack.

HOME RANGES AND MOVEMENTS

A summary of home range data for instrumented wolves, by season and for the entire period each animal was radio-collared, is presented in Table 6. The wolves captured in 1987 are not included because, at the end of this reporting period, they had not been followed for a complete season.

Table 6. Minimum Convex Polygon Home Ranges in km^2 and (number of locations).

	1984		1985			1986			1987	Total
Wolf	A[a]	W[b]	D[c]	A	W	D	A	W	D	
W8401	591 (9)	1532 (34)	3737 (37)	1801 (34)	1453 (50)	1431 (16)	545 (12)	165 (8)	136 (9)	5964 (209)
W8550			194 (66)	718 (52)	614 (82)	355 (108)	1152 (71)	749 (89)	336 (32)	1795 (500)
W8551				513 (35)	615 (84)	714 (97)	1155 (75)	414 (11)	NA	1466 (302)
W8653						730 (78)	1245 (72)	790 (99)	417 (64)	1393 (290)
W8654							1783 (34)	1023 (99)	513 (31)	2455 (165)

[a] Autumn: 15 August - 30 November
[b] Winter: 1 December - 14 April
[c] Denning: 15 April - 14 August

The wolf with the largest home range, 5964 km^2, was W8401, a lone wolf through much of the reporting period. This home range was more than twice as large as any of the other instrumented wolves, and is larger than any ranges reported by Carbyn (1980), Fritts and Mech (1981), ///??. The Magic Pack, based on the movements of W8550, had a home range of 1795 km^2, still considerably larger than most of those reported in the literature (Carbyn 1980, Fritts and Mech 1981,). When male W8401 found a mate in autumn, 1986, his calculated home range size was much reduced for the next 2 seasons. The number of relocations for W8401 after autumn 1986, however, was low due to the remoteness of his locations.

The home ranges of other instrumented wolves belonging to the Magic Pack were very similar to that of W8550, the alpha female of the pack, except during the denning period. During this time, movements of alpha females were reduced. The average home range size for denning females (W8550 for 1985 - 1987; W8653 in 1987) was 326 km^2 (s.e.=47). W8401, an alpha male in 1987, also had a small home range during the denning period that year (136 km^2). Autumn and winter ranges were roughly twice this size. Caution should be used in interpreting these numbers, because the 1987 denning period was truncated by the end of the reporting period and some wolves were caught partway into the denning period (see Table 6).

The size of home ranges reported here may be larger than those reported elsewhere for several reasons. The population we are studying is a newly colonizing population with no established wolf territories and an abundant prey base. Another important reason may be the topography of the study area. Wolves in this study used the valley bottoms almost exclusively, while the minimum convex polygon method of calculating home range does not take this into account. Hence, high ridges and mountains are included within the calculated home range that were never recorded as being used by the animals (see Fig. 4). Harmonic mean home ranges were also calculated and plotted, but also included large areas the wolves never used. Minimum convex polygon results are reported here because they are most commonly reported in the literature.

Singer (1979) reported that the occasional wolf tracks followed in and near GNP during winter often crossed high mountain passes. This only rarely occurred during this study period and only with W8401 when he was traveling widely.

Another probable reason for the large home range size we report for W8401 was his social status. This young male was a lone wolf until autumn 1986, and may have had to rely more on scavenged food items than the Magic pack. He may have also been looking for other lone wolves and a mate. During the breeding season in 1986 he was often found in close proximity to the Magic Pack, perhaps for this reason. When he did find a mate in autumn 1986, his calculated home range size became much smaller.

Alpha females tended to make long movements shortly before entering a den. In 1986, W8550 moved 50, 16, and 5 km between the 3 locations (8 days) before becoming very sedentary. In 1987, she also moved considerably, but because we didn't think she was an alpha female, she was not tracked daily. W8653, the alpha female of the 1987 Camas Pack, was also very active immediately prior to denning. Only 13 days before she was firmly established at her den (23 April), she was 76 km northwest of the densite, and 5 days before, she was 57 km northwest of the densite.

Home ranges of the 3 packs during the 1987 denning period (through 30 June) are presented in Fig. 7. Overlap between the Sage Creek Pack and the Camas Pack was due primarily to the extensive movements of W8653 just prior to denning on 23 April, and Figure 7 data began on 15 April. It is too early to determine the home range sizes of the Camas, Sage Creek, and Wigwam Packs due to their recent formation.

Two of the three packs currently in the North Fork are spending most of their time in southeastern BC, while the third pack, the Camas Pack, is spending part of its time there. The dispersal movement of W8551 north rather than south. Since a considerable amount of unoccupied potential wolf range exists north of the border, some dispersers may colonize areas there before Montana. Recovery of the wolf population within the Northern Continental Divide Ecosystem in Montana may therefore still be a distant goal even after the current population grows to 10 breeding pairs.

Figure 7. Denning season home ranges 15 April to 30 June, 1987.

FOOD HABITS

Food habits data consist of items identified in wolf scats and location of carcasses that wolves fed upon. These data were divided into 3 collection periods: spring-summer (Apr. 15 - Aug. 14), autumn (Aug. 15 - Nov. 30), and winter (Dec. 1 - Apr. 14).

The spring-summer period coincides with the pup rearing season when pups remain at homesites to which attending adults regularly return. Scats were collected at the homesites after they were abandoned by the wolves. During the autumn period, pups remain decreasingly less time at consecutive rendezvous sites, eventually adopting the nomadic behaviour of the older wolves in the pack. The less time that wolves use a rendezvous site, the more difficult it is to discover verifiable wolf scats until snow cover arrives. The autumn period includes the hunting seasons of both Montana and British Columbia and a concomitant potential for hunter wounded or killed animals. By the winter period, the entire wolf pack is nomadic and snow cover is complete. Even so, unstable weather, particularly in the late autumn and early winter, often erases the track record and covers scats.

Contents of 217 wolf scats were identified for 7 seasons (Table 7). Ninety-three percent of the scats contained hair of one species, 6 percent had 2 species and 1 percent had 3 species. Considering only ungulate hairs, 95, 4, and 1 percent of the scats were of 1, 2, and 3 species, respectively.

As would be expected, large ungulates are the most frequently occurring items in the wolves' diet. The importance of ungulates is even more pronounced when the relative biomass of each species is estimated (Table 7).

The one scat with horse hair in it was collected within 7 days of the Magic Pack feeding on a horse as carrion near an outfitter's home in BC. It is not known if the mountain goat present in autumn 1985 was scavenged or killed. It was the only species represented in 1 of 6 same-aged scats collected from the Magic Pack along the same trail, the other 5 each containing 100% deer hair.

Deer were the most frequently occurring species identified in scats, consistently present in all seasons and years. Their relative importance seemed to decline in the autumn as moose and/or elk frequencies increased. Deer became the prevalent item in winter wolf scats concurrently with the decline of moose in the scats following the range expansion of the Magic Pack south into GNP in mid-November 1985. The relative frequency of deer decreased in the spring-summer season, the difference being made up by species largely absent from the Autumn and Winter seasons.

Moose, the most frequently occurring item in scats collected during the Winter 1984-85, were also common during the autumn seasons of 1984 and 1985. Moose was not found in scats after Autumn 1985. Moose were uncommon, but present, in scats collected at homesites from the 1985 summer season and all of these were hairs from calves.

Table 7. Relative frequency of occurence and (relative biomass of prey items)[a] by all scats and seasons.

Species	Aut '84	Wtr 84-5	Spr-Sum '85	Aut '85	Wtr 85-6	Aut 86	Wtr 86-7
Deer	77.5% (68.8%)	32.9% (15.3)	69.2% (65.0)	49.0% (24.6%)	85.8% (73.7%)	50.0% (24.6%)	91.0% (75.0%)
Elk	0.0 (0.0)	3.2 (4.6)	8.3 (14.4)	33.6 (51.7)	10.0 (26.3)	50.0 (75.4)	9.0 (25.0)
Moose	8.6 (29.5)	42.5 (76.3)	1.9 (3.6)	11.1 (21.6)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)
Hare	7.1 (1.7)	7.1 (0.8)	5.1 (3.1)				
Beaver			5.1 (4.7)				
Mt. Goat				3.7 (1.6)			
Coyote			5.1 (4.6)	2.6 (0.5)			
Horse		7.1 (2.9)					
Sciuridae			5.1 (2.9)				
Porcupine			2.6 (1.7)				
Mustelidae					1.9 (unk.)		
Peromyscus	6.7 (<0.1)	7.1 (<0.1)			1.9 (<0.1)		
No. scats	14	14	39	27	53	4	66

[a] $RB_i = [(0.38 + 0.02x_i)RF_i] \; / \; \Sigma[(0.38 + 0.02x_i)RF_i]$, where RB_i is the relative biomass of species i, x_i is the mean weight (kg.) of species $_i$, and RF_i is the relative frequency of species x_i in the scat data. Regression equation from Floyd et al. (1978). See Appendix I for values of x_i.

Elk, like deer, were consistently present in the scat data. The absence of elk from the autumn 1984 season is probably an artifact of small sample size. Likewise, the autumn 1986 sample size defies extrapolation. For the winters of 1985-86 and 1986-87, when the Magic Pack was radio-collared and utilizing the same terrirory, primarily GNP, the relative frequencies of deer and elk in wolf scats were not significantly different (X^2=1.12, p>0.25)

Beaver, while common in the study area (Singer, 1979), were of minor importance in the wolves' diet. They comprised 4.7 percent of the spring-summer 1985 biomass and were not represented in any autumn or winter season although 1 beaver carcass was discovered in the winter of 1986-87.

Comparisons of scat contents of the Magic Pack for all winter seasons suggests a dietary shift from a moose - deer emphasis to deer - elk. It should be remembered that there were no radio collars on the Magic Pack until May 1985. Scat collection up until that time was done by doing ski and snowmobile reconnaissance for wolf tracks and then following them once they were found. As Cowan (1947) and Carbyn (1974) both noted, a large potential for biasing the food habits data exists when scat and kill data are collected from restricted portions of a territory, especially when ranges of the major prey species are disjunct. The sample size for this period is too small to safely generalize a pattern of prey selection.

Seventy-five carcasses fed upon by wolves, whether killed by wolves or scavenged, were examined (Table 8). Forty-four percent (33) of the carcasses were known kills, 49% (37) were probable kills, and 7% (5) were scavenged. Carcasses included 34 elk, 32 deer, 2 moose, 1 unidentified ungulate, 2 cougars, 1 porcupine, 1 beaver, 1 ruffed grouse, and 1 Microtus (the latter had been regurgitated). Only 1 of the 32 deer carcasses was known to be a mule deer. Excluding this animal, all deer remains were found in white-tailed winter range and were believed to be white-tails.

Most prey carcasses were almost completely consumed in a few days (Table 8). The percent consumption of carcasses did not follow a normal distribution since a high proportion of them were at least 90% consumed and a very low proportion were <50% eaten. Percent carcass consumed was determined as follows:

99%	remains = a little hair and blood.
95%	remains = several vertebrae and/or other bones, 1 - 3 lower legs, no soft tissue, small amount of hide.
90%	remains = 2-4 legs, much hide, most of skeleton gleaned and intact, possible intact head or neck.
85%	remains = nearly complete skeleton with some soft tissue.
<85%	visual estimate bared on % of total volume of carcass remaining.

Table 8. Carcasses fed upon by wolves.

Catalog	Estimated Date Killed	Date Found	Species	Age[a]	Sex	General Location	Carcass Type[b]	Marrow Index[c]	% Carcass Consumed[d]
100	≤ 11-4-85	11-6-85	WT Deer	7 Yrs	M	Sage Crk, BC	X	1	90
101	≤ 3-26-85	3-30-85	Moose	2 Yrs	M	Sage Crk, BC	X	-	95
102	≤ 11-19-85	11-23-85	Elk	2 Yrs	M	Big Prairie, GNP	X	-	90
103	≤ 2-26-85	3-2-85	Elk	5 Yrs	F	Elder Crk, BC	X	-	95
104	≤ 1-31-86	2-1-86	WT Deer	2 Yrs	F	Camas Crk, GNP	X	-	10
105	≤ 12-1-85	12-15-85	Elk	4 Yrs	F	Nettie Crk, BC	P	4	90
106	≤ 2-24-86	2-26-86	Elk	10 Yrs	M	Camas Crk, BC	X	2	40
107	≤ 12-1-85	12-15-85	Elk	9 Yrs	F	Nettie Crk, BC	P	4	90
108	≤ 10-9-85	10-10-85	WT Deer	Fawn	-	Couldrey Crk, BC	X	-	99
109	≤ 10-10-85	10-11-85	Elk	-	-	Sage Crk, BC	P	-	99
110	≤ 10-4-85	10-18-85	Elk	2 Yrs	M	Commerce Crk, BC	S	1 1/2	95
111	≤ 12-12-85	12-19-85	WT Deer	-	-	Bowman Crk, GNP	X	2	95
112	≤ 12-19-85	12-26-85	Elk	Calf	-	Big Prairie, GNP	P	-	95
113	≤ 1-7-86	1-8-86	WT Deer	-	-	Camas Crk, GNP	X	-	99
114	≤ 1-11-86	1-12-86	Elk	Calf	-	Ford Crk, GNP	P	-	99
115	≤ 1-9-86	1-13-86	WT Deer	-	-	Coal Crk, GNP	P	-	95
116	≤ 1-10-86	1-15-86	WT Deer	-	-	Anaconda Crk, GNP	X	-	99
117	≤ 2-4-86	2-8-86	WT Deer	-	-	Kintla Lk, GNP	P	3	99
	≤ 2-4-86	2-8-86	WT Deer	-	-	Kintla Lk, GNP	P	4	95
118	≤ 2-3-86	2-9-86	WT Deer	Adult	M	Kintla Lk, GNP	P	2	99
119	≤ 2-11-86	2-12-86	Elk	Calf	-	Sage Crk, BC	P	2	90
120	≤ 2-27-86	2-28-86	Elk	Yrlg	M	Big Prairie, GNP	X	1	90
121	≤ 2-24-86	3-3-86	Elk	Calf	-	Sage Crk, GNP	P	-	90
122	≤ 4-19-86	4-20-86	Elk	Calf	-	Polebridge, PRIV	X	5	90
123	≤ 4-22-86	4-25-86	Elk	8 Yrs	M	Big Prairie, GNP	P	-	90

Table 8. Carcasses fed upon by wolves (continued).

Catalog	Estimated Date Killed	Date Found	Species	Age[a]	Sex	General Location	Carcass Type[b]	Marrow Index[c]	% Carcass Consumed[d]
125	≤ 11-6-86	11-10-86	Elk	Adult	M	Kintla Crk, GNP	P	1	90
126	≤ 11-17-86	11-20-86	Elk	Adult	-	Sullivan Mdw, GNP	P	-	95
127	≤ 11-17-86	11-20-86	WT Deer	10 Yrs	F	Sullivan Mdw, GNP	P	-	95
128	≤ 11-17-86	11-20-86	Porcupine	-	-	Sullivan Mdw, GNP	P	-	99
129	≤ 11-17-86	11-20-86	WT Deer	-	-	Sullivan Mdw, GNP	P	1	95
130	≤ 11-19-86	11-21-86	WT Deer	Fawn	-	Sullivan Mdw, GNP	P	-	99
131	≤ 11-22-86	11-23-86	WT Deer	2 Yrs	M	Anaconda Crk, GNP	P	1	90
132	≤ 11-27-86	11-30-86	WT Deer	Fawn	F	Starvation Ridge, GNP	X	-	90
133	≤ 11-30-86	12-2-86	Elk	Adult	M	Doverspike, GNP	P	-	95
134	≤ 11-25-86	12-2-86	Ungulate	-	-	Big Prairie, GNP	P	2	99
135	≤ 12-1-86	12-2-86	Elk	Calf	-	Big Prairie, GNP	X	2 1/2	30
136	≤ 12-4-86	12-11-86	Elk	4 Yrs	M	Akokala Crk, GNP	P	1	90
137	≤ 12-17-86	12-20-86	Elk	Calf	-	Sage Crk, BC	X	2	85
138	≤ 12-21-86	12-26-86	WT Deer	Fawn	-	Sullivan Mdw, GNP	P	-	95
139	≤ 12-2-86	12-3-86	Elk	Calf	-	Doverspike, GNP	X	3	65
140	12-1-87	1-9-87	Elk	3 Yrs	F	Couldrey Crk, BC	S	1	90
141	≤ 12-20-86	1-7-87	Cougar	Immature	-	Kishenehn Crk, GNP	S	3 1/2	25
142	≤ 1-8-87	1-10-87	Elk	Calf	-	Colts Crk, USFS	X	1 1/2	95
143	≤ 1-11-87	1-12-87	Elk	Calf	-	Garnet Lk, USFS	X	1	90
144	≤ 1-12-87	1-14-87	Elk	Yrlg	-	Kintla Crk, GNP	X	1	80
145	≤ 1-12-87	1-14-87	Microtus	-	-	Kintla Crk, GNP	P	-	100
146	≤ 1-19-87	1-21-87	Elk	Yrlg	M	Logging Crk, GNP	X	4	10
147	≤ 1-21-87	1-22-87	WT Deer	Fawn	M	Sullivan Mdw, GNP	X	4 1/2	50
148	≤ 1-20-87	1-23-87	WT Deer	-	-	Sullivan Mdw, GNP	P	-	99
149	≤ 1-23-87	1-24-87	Cougar	Kitten	-	Anaconda Crk, GNP	X	-	80

Table 8. Carcasses fed upon by wolves (continued).

Catalog	Estimated Date Killed	Date Found	Species	Age[a]	Sex	General Location	Carcass Type[b]	Marrow Index[c]	% Carcass Consumed[d]
150	≤ 1-23-87	1-24-87	WT Deer	Fawn	-	Anaconda Crk, GNP	X	-	95
151	≤ 1-24-87	1-25-87	WT Deer	Yrlg	-	Sullivan Mdw, GNP	P	-	99
152	≤ 1-24-87	1-25-87	WT Deer	10 Yrs	-	Sullivan Mdw, GNP	X	1	80
153	≤ 1-25-87	1-27-87	Moose	2 Yrs	F	Akokala Crk, GNP	P	5	60
154	≤ 1-27-87	1-29-87	Elk	Calf	-	Doverspike, GNP	P	-	95
155	≤ 2-4-87	2-5-87	Elk	Yrlg	F	Kishenehn Crk, GNP	X	1	95
156	≤ 2-10-87	2-12-87	Elk	7 Yrs	M	Kishenehn Crk, GNP	X	1	80
157	12-1-86	1-29-87	WT Deer	8 Yrs	-	Doverspike, GNP	S	-	99
158	1-10-87	1-29-87	WT Deer	Yrlg	-	Doverspike, GNP	P	-	99
159	≤ 2-3-87	2-10-87	Mule Deer	-	-	Polebridge, F.S.	P	1	95
160	≤ 2-13-87	2-15-87	Elk	2 Yrs	M	Doverspike, GNP	X	2	90
161	≤ 2-15-87	2-17-87	WT Deer	5 Yrs	F	Bowman Lk, GNP	X	4	90
162	≤ 2-19-87	2-20-87	Elk	4 Yrs	M	Anaconda Crk, GNP	X	2 1/2	50
163	≤ 2-19-87	2-21-87	Beaver	-	-	N Fk Bottoms, GNP	P	-	95
164	≤ 2-23-87	2-24-87	WT Deer	Fawn	-	Sullivan Mdw, GNP	X	1 1/2	95
165	≤ 2-25-87	2-26-87	WT Deer	Adult	-	Quartz Crk, GNP	X	-	95
166	≤ 3-5-87	3-7-87	Ruffed Grouse	-	-	Starvation Crk, GNP	X	-	99
167	≤ 3-4-87	3-7-87	WT Deer	Adult	-	Starvation Crk, GNP	P	1	90
168	≤ 3-14-87	3-16-87	Elk	Yrlg	M	Kintla Crk, GNP	P	-	5
169	≤ 3-22-87	3-22-87	WT Deer	9 Yrs	F	Lone Pine Prairie, GNP	P	2	90
170	≤ 3-21-87	3-23-87	Elk	2 Yrs	M	Big Prairie, GNP	X	3	15
171	≤ 3-30-87	4-1-87	WT Deer	7 Yrs	F	Kishenehn Crk, GNP	P	2	90
172	≤ 4-1-87	4-3-87	WT Deer	6 Yrs	-	Placer Pt, USFS	P	2 1/2	95
173	≤ 4-1-87	4-3-87	WT Deer	Imm.	-	Placer Pt, USFS	P	2	25
174	≤ 2-10-87	2-28-87	Elk	7 Yrs	M	Bowman Lk, GNP	S	4 1/2	15

[a] Aged by cementum annuli & tooth eruption patterns in young of the year and yearlings.
[b] X-known wolf kill, P-probable wolf kill, S-scavenged by wolves.
[c] after Cheatum (1949).
[d] see page 28.

Surplus killing (Kruuk 1972), if it occurred at all, was rare. Wolves during this study ate almost all of what they killed. Sixty-eight percent of 34 elk carcasses and 90% of 32 deer carcasses were at least 90% consumed (Table 8). Deer carcasses were more fully utilized than elk carcasses, probably because the skeletal structure is smaller and more easily chewed and digested and because the smaller animals are more likely to be completely consumed by the pack at one feeding. Of the 7 known kills less than or equal to 50% consumed, 4 were found within 24 hours of the kill, perhaps causing the wolves to leave the kill before they were finished. In addition, prey carcasses completely consumed were undoubtedly more difficult to find than those partially consumed. Often the only remains of a deer were hair and blood in the snow. The probability of finding such carcasses was low, so a higher percentage of kills were completely consumed than is reported here.

Prey abnormalities were very difficult to detect because of the high degree of carcass utilization. One older male white-tailed deer had a badly deformed foot which possibly hindered its escape from wolves. Wolves fed upon two bull elk that had been wounded through the face by hunters. It could not be determined if the wolves scavenged or killed these hunter-wounded elk. Most prey carcasses were thoroughly utilized and many incidents of wolves killing prey with abnormalities or scavenging probably went undetected. Movements of the wolf packs indicated the wolves probably made use of gut-piles and hunter-wounded animals (i.e., during the Canadian hunting season in September and October the wolves moved north into BC, and when the US hunting season opened in late October and November the wolves moved south). In November 1986, a US hunter reported watching a light colored wolf with a radio collar feed on a cow elk which he determined to be a hunter loss after the wolf was frightened away. W8550 had been simultaneously radio-located in the same area.

The first 8 days of the 36-day 1985 and 1986 Montana big-game hunting seasons were open to either sex deer and elk. The remainder of the seasons were closed to antlerless animals. Hunters would therefore be expected to harvest a higher percentage of antlered than antlerless animals. Hunter check station data indicated that hunters harvested approximately an even sex ratio of elk but a higher proportion of males for mule deer and white-tailed deer. In contrast, wolves fed on more bull (15) than cow (5) elk. While no data were available on sex ratios in the study area, elk populations are usually skewed toward females. Even assuming a conservative even sex ratio, bull elk were apparently selected over cows (X^2=5.00, $p<0.05$). Carbyn (1974) reported an equal number of bull and cow prey carcasses found in Jasper National Park. Wolves killed approximately an equal percentage of male and female white-tailed deer, similar to results reported by Fritts and Mech (1981).

Male deer and elk go into winter in relatively poor shape after not feeding, expending much energy during the autumn rut period (Taber et al.,1982; Verme and Ullrey, 1984). More cows were killed in mid- and late-winter whereas bulls were killed throughout the winter (Table 8). More bucks were killed early in the winter while more does were killed later in the winter. This trend could be due to the high demands of the rut for males. Another possible explanation could be that males are disproportionately wounded during the hunting season and become easier prey.

A little more than one-third (37%) of elk prey carcasses were calves (Figure 8). Carbyn (1974) reported that 39% of the elk preyed upon in Jasper National Park were calves. He also reported that calves represented 26% of the elk killed by wolves in Riding Mountain National Park, Manitoba (Carbyn 1980). Forty percent of the known-age deer carcasses fed upon by wolves were less than 1 year old (Figure 8). In Minnesota, Fritts and Mech (1981) reported that 51% of the white-tailed deer killed by wolves during winter were fawns. This was somewhat higher than other studies of deer and wolves (17-30%) they reviewed. Fawns and calves were common prey items in scats collected from the spring-summer 1985 homesite. Thirty-three percent of the scats from this season were of fawns, 7.5 percent were elk calf, and 2.5 percent were of moose calf. Wolves appear to be taking a higher proportion of older age classes of deer than hunters, but this does not appear to be the case with elk (Figure 8). Fritts and Mech (1981) reported similar results for deer.

Jenkins (1985) estimated the relative abundance of wintering ungulates in the North Fork valley between Big Creek and the Canadian border by counting tracks in the snow along transects. He found that white-tailed deer were roughly 1.9 times as abundant as elk and 6.6 times as abundant as moose. Deer were more common in the southern portion of his study area, elk were relatively evenly distributed, and moose were found primarily in the north.

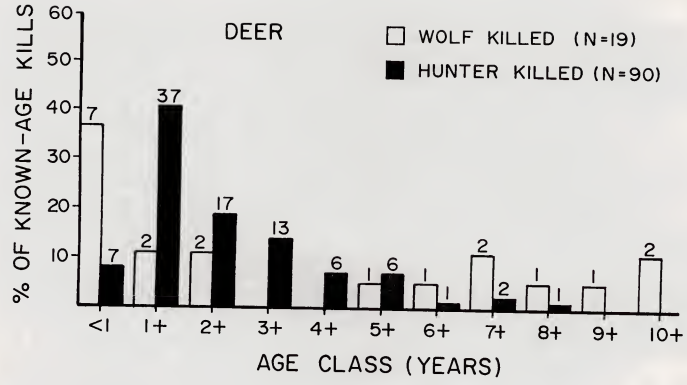
Relating this to the data on carcasses fed upon by wolves (32 deer, 34 elk, and 2 moose) would suggest a slight preference for elk and avoidance of moose. Because deer carcasses were often completely consumed, some were undoubtedly missed. Scat data corroborate the avoidance of moose in the presence of significant deer and elk populations. This is consistent with studies in Jasper National Park, Alberta (Carbyn, 1974), and Riding Mountain National Park, Manitoba (Carbyn, 1983) where moose were preyed upon substantially less than their availability when deer and elk were present.

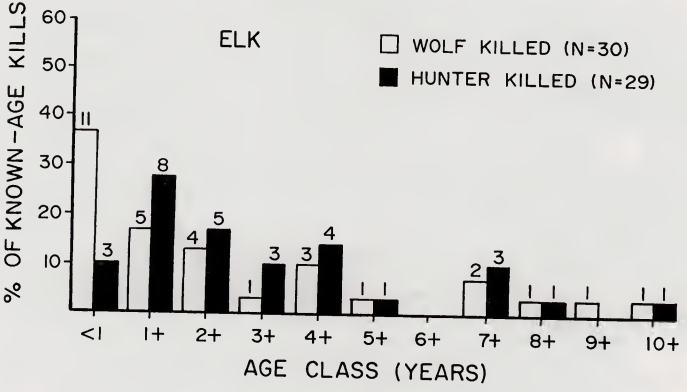
Conversely from the carcass data, the scat data for Winters 1985-86 and 1986-87 suggests a significant preference for deer over elk. Carbyn (1974) observed a similar disparity between carcass and scat data for elk and deer.

A substantial effort was made during the winter of 1986-87 to regularly collect carcass and scat data. For the period of 12/1/86 to 4/1/87, 17 deer and 16 elk carcasses were found and 66 scats were analyzed. The 66 scats were distributed over 26 sampling periods averaging 4.54 days (SD = 2.75) apart. Scats were not collected around kills.

Weaver (1979), in a review of elk predation by wolves, calculated consumption rates per wolf by extrapolating reported predation rates and using biomass data for Rocky Mountain elk. For various combinations of kill rates and age and sex selection he calculated consumption rates in the range of 5.7 - 7.5 kg/wolf/day.

Choosing an average for the range given above, 6.6 kg, the Magic Pack consumed 6924 kg of prey over 121 days (1049 wolf days adjusting pack size for the periods when W8550 and W8551 were absent). Using mean species weights of 54 kg and 211 kg for deer and elk, respectively, (Appendix I), the carcasses discovered represented 4294 kg of biomass known consumed. Multiplying the


DEER
WOLF KILLED (N=19)
HUNTER KILLED (N=90)
% OF KNOWN-AGE KILLS
60
50
40
30
20
10
7
7
2
37
2
17
13
6
1
6
1
1
2
2
1
1
1
2
<1
1+
2+
3+
4+
5+
6+
7+
8+
9+
10+
AGE CLASS (YEARS)


ELK
WOLF KILLED (N=30)
HUNTER KILLED (N=29)
% OF KNOWN-AGE KILLS
60
50
40
30
20
10
11
3
5
8
4
5
1
3
3
4
1
1
2
3
1
1
1
1
1
<1
1+
2+
3+
4+
5+
6+
7+
8+
9+
10+
AGE CLASS (YEARS)

relative biomass estimates derived from the scat data (Table 7) to the balance of 2630 kg and dividing by mean species weights yields an estimate of 37 deer and 4 elk being consumed in addition to the carcasses found. This totals 54 deer and 20 elk consumed during the 121 day period, a 2.7 deer : 1.0 elk ratio.

This ratio assumes that the mean weights of the deer and elk from the scat data were equivalent to the animals in the carcass data (where the estimates were derived). This is may not be the case, since young of the year, deer fawns in particular, are often completely consumed, potentially increasing mean weights and depressing numbers of animals.

Comparing the 2.7 deer : 1.0 elk utilizaion ratio with Jenkins' 1.9 deer: 1.0 elk availability ratio suggests that deer were selected over elk, but not substantially (X^2=2.83, $0.10 > p > 0.05$). Again, the utilization ratio is probably low, but Jenkins' ratio is, likewise, almost assuredly low. While his track transects were in the river bottom, most of the deer in the north end of the study area in GNP winter east of the bottoms, towards Kintla and Upper Kintla Lakes, where snow depths dramatically decrease.

The kill rate for the 121 day period for deer and elk combined is 1 animal / 1.6 days. Given the relative scarcity of elk hair in the scats, it would seem that we did find most of the elk kills made by the Magic Pack for the 121 day period, 80 percent according to the calculations. Because of the relatively large size of elk, estimates of their absolute numbers are fairly stable even given the range of possiblilities inherent in the assumptions of the above calculations. We feel that the kill rate for elk, 1 elk / 6.1 days is a good estimate for this period, pack size, and prey complex.

SUMMARY AND MANAGEMENT IMPLICATIONS

The wolf monitoring and research effort conducted in the North Fork study area over the past 3 years has documented substantial changes in the wolf population. When the first wolf (W8401) was radio-collared in 1984, he and the 6 nonradio-collared members of the Magic Pack were the only wolves present in the area. In 1985, W8550 had a litter of 7 pups just north of GNP and in 1986 she had the first litter (5 pups) in GNP in some 50 years. Now, in mid-1987, we have 8 radio-collared wolves, 3 successful dens, at least 15 new pups, and a population of perhaps 30 wolves.

During the past year we have witnessed splitting of the Magic Pack into 2 packs, the Camas Pack and Sage Creek Pack, and formation of the new Wigwam Pack by formerly lone male W8401. Although the recovery plan goal is 10 breeding pairs, and there are 3 breeding pairs in the study area, only one of those breeding pairs is in the United States, the other 2 in British Columbia. During the past year we have also witnessed a major long range dispersal by female W8551 890 miles to the north to the Peace River area near the BC/Alberta border. If she had moved south instead, she would have been well past Yellowstone National Park in the Rocky Mountains. Although all other radio-collared wolves are accounted for, we may have had additional non-

radioed wolves disperse from the study area that we were not able to document. This emphasizes the need to document dispersal.

In March 1986, 4 wolves apparently left the Magic Pack. Shortly thereafter, project and GNP personnel found tracks of 4-5 wolves in the St. Mary area on the east side of GNP. It was easy to speculate that the wolves on the east side originated from the wolves that left the Magic Pack. However, in the wolf control actions that occurred approximately 15 km east of St. Mary in summer 1987, it was learned that all but one adult was gray, whereas all 4 that left the Magic Pack were black. The black 3-legged wolf that was taken had been seen and photographed in GNP the previous winter.

The wolves appear healthy, there is rapid growth in the young, and they attain large size and weight. We feel that natural mortality will be very low in the near future. The major source of wolf mortality will probably continue to be human-induced. If a major portion of the wolf population continues to use GNP, human-caused mortality will be minimized, because there is no legal hunting or trapping in the park. BC initiated its first hunting and trapping season for wolves in the North Fork in 1987. With 2 packs, containing 6 radio-collared adults, residing there, the WEP will be able to document wolf mortality that might occur.

A substantial shift in home range of the Magic Pack occurred in November 1985, when the pack shifted its entire home range from north of the Canadian border southward into GNP. Only 3 locations out of 96 after 11 November 1985 and before denning (15 April 1986), overlapped the 117 locations prior to 11 November (1 July to 10 November 1985). There was no overlap during the denning season (15 April to 30 June). After the pack split in winter of 1987, one densite was near the 1985 densite, just north of GNP, and the other was further south in GNP than the 1986 densite. Thus, we have had 2 separate densites in GNP and we know that there are numerous adequate densites both in GNP and on the FNF.

We believe that wolves have had relatively little impact on the prey population in the area at this point in wolf recovery. Most prey animals taken by wolves in winters of 1986 and 1987 were taken in GNP. Although it is very difficult to estimate rates of kill for different prey species, we estimated that approximately 2.7 deer were taken for each elk taken by wolves in winter 1987. With the pack split that occurred in 1987, we may see some shifts in prey utilization in winter 1988, especially if the Sage Creek Pack stays north of the border. Few deer winter in the North Fork, BC.

Additional trapping will be conducted in autumn 1987 and again in spring of 1987 if necessary. We would like to capture additional pups in particular, so that we are better able to document dispersal as it occurs, and determine where dispersers move. The importance of dispersal in wolf recovery cannot be overemphasized.

Although we are conducting a parallel investigation of white-tailed deer in the study area, there is much more that needs to be done in monitoring and research on the prey base. This appears to be the next most important area needing investigation.

Glacier National Park, in consultation with the WEP, delayed spring opening of dirt roads in the park that were near the 1986 and the 1987 densites. In 1986 an area closure near the den was implemented to avoid disturbance to the wolves. In 1987, although the densite was close to a road, no area closure was put into place. It appeared that subsequent human use of the area may have caused the wolves to move their pups a short distance, but apparently with no detrimental effect. The road was not opened until late May, and the pups were apparently big enough to be moved without harm.

Finally, the WEP put considerable effort into completing a major prospectus that outlines the studies that are needed to assure that all facets of wolf recovery are adequately addressed. Wayne Brewster, U.S. Fish & Wildlife Service; Cliff Martinka, GNP; Bill Ruediger, U.S. Forest Service; Bart O'Gara, Montana Cooperative Wildlife Research Unit; and Bob Ream and Dan Pletscher, School of Forestry, University of Montana served on this commitee and Dr. L.D. Mech provided technical critique. The prospectus will provide direction for future monitoring and research.

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APPENDIX I

Common Name	Scientific Name	Weight (kg)[a,c]
Beaver	Castor canadensis	12.5
Cougar	Felis concolor	NA
Coyote	Canis latrans	12.0
Elk	Cervus elaphus	211.0
		40.0[b]
Hare	Lepus americanus	1.2
Horse	Equus caballus	450.0
Moose	Alces alces	270.0
		45.0[b]
Mt. Goat	Oreamnos americanus	45.0
Mule Deer	Odocoileus hemionus	54.0
		13.0[b]
Porcupine	Erethizon dorsatum	7.0
White-tailed Deer	Odocoileus virginianus	54.0
		13.0[b]
Wolf	Canis lupus	NA

[a] Weights used for relative biomass estimates (Table 7) for autumn and winter seasons and winter 1986-87 prey consumption estimate.

[b] Weights used for relative biomass estimates (Table 7) for spring summer season.

[c] Seasonal weights for deer, elk, and moose computed from seasonal averages for age and sex classes, weighted by relative frequencies in the carcass data for autumn and winter seasons and relative frequencies in the scat data for the spring-summer season.